Results of arthrodesis in neuropathic feet

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We describe the results of arthrodesis for the treatment of recurrent acute neuropathic bone disease in 24 feet and of chronic disease with deformity in 91 feet, undertaken between January 1984 and December 2003. All were due to leprosy.

Correction of the deformity was achieved in 80 of 106 feet (76%) and fusion in 97 of 110 feet (88%). In the 24 feet in which recurrent neuropathic bone disease was the reason for surgery, 17 (71%) obtained stability while in seven (29%) symptoms recurred post-operatively. Complications were experienced following 58 of the 110 operations (53%). In patients presenting primarily with deformity with a minimum follow-up of two years (79 feet), there was a reduced frequency of ulceration in 40 (51%). Normal footwear could be worn by 32 patients (40%) after surgery, while 40 (51%) required a moulded insole.

Arthrodesis of the ankle in the neuropathic foot due to leprosy has a good overall rate of success although the rate of complications is high.

The neuropathic joint was first described by Charcot in 1868. In the last four decades there have been considerable advances in the understanding of the pathophysiology and treatment, derived from pioneering work in leprosy hospitals by Harris and Brand and Warren. The current management has been well described recently.

The surgical treatment of neuropathic bone disease, also referred to as neuro-osteoarthropathy, has advanced. Previously, it was thought that the Charcot joint was inoperable because of the high rate of complications. Patients were left to suffer from progressive deformity, ulceration and in many cases ultimate loss of the limb. It was found that immobilisation of the joint, preferably with partial weight-bearing in a total contact cast, allowed consolidation of the bone. If corrective surgery was required, but was delayed until healing and consolidation of the acute neuropathic changes had occurred, the rate of complications fell dramatically, but their occurrence following arthrodesis for neuropathic bone disease remained higher than for other aetiologies. Shibata, Tada and Hashizume, described the results of arthrodesis of the ankle using the principles described by Drennan, Fahey and Maylahn. This involved careful removal of all cartilage and debris, thorough removal of sclerotic bone down to bleeding, well-vascularised bone, meticulous fashioning of congruent surfaces for apposition, firm fixation with an intramedullary rod or other device and complete debridement of all synovial and scarred capsular tissue. In spite of this 27% of arthrodeses in their series failed to unite.

It is commonly felt that correction of the deformities associated with neuropathic bone disease decreases the frequency of ulceration in the affected foot, a finding supported by Ebenezer, Partheebarajan and Solomon. Warren and Nade also state that correction of the deformity should allow the patient to wear normal shoes, a considerable advantage when provision of specialised footwear is limited.

We describe our experience of arthrodesis in the neuropathic foot caused by leprosy.

Patients and Methods

This was a retrospective study carried out at our institution. Since this is the only institution in the country performing such operations the findings can be considered as national results. The medical records of all patients (128) undergoing an arthrodesis involving the foot for treatment of leprosy-related neuropathic bone disease between January 1984 and December 2003 were reviewed and data compiled. Six patients with neuropathic bone disease from causes other than leprosy were excluded, as were 13 patients with revision arthrodeses. A further patient was excluded because we did not have his complete medical

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Operative technique. Cases was no deformity present. rocker-bottom foot (7) and unclassified (11). In only four equinus or equinovarus (26 cases), varus (48), valgus (8), osteomyelitis before the corrective arthrodesis. achieved.
tist felt that adequate modification of footwear could not be surgical correction if modification to footwear failed either to with or developed deformities of the feet were offered sur-
at the end of the procedure. In all cases osteotomies were made using osteotomes and care was taken to obtain congruent surfaces, through viable bone if possible. Minimal bone grafting was used. Fixation was by a wide variety of techniques, but usually involved staples and/or pins. A suction or rubber drain was left in place for 48 hours post-operatively. The plaster cast was applied as a non-weight-bearing cast and usually changed to a walking total-contact cast after one month. In accordance with the recommenda-
tions of Warren and Nade, it was retained for three months for a subtalar arthrodesis, for six months for an ankle arthrodesis, and for six to nine months for a midfoot fusion.
After removal of the plaster cast the patients were required to wear a shoe with a semi-rigid sole, for one year after which they were allowed to wear regular shoes with microcellular rubber insoles if the fitting was reasonable, or orthotic insoles and/or orthotic shoes. A wide variety of operative procedures by several surgeons using several methods of fixation was used on differing deformities. The larger number of variables with small subgroups did not allow comparison of different groups.
We determined the adequacy of the correction achieved in both groups, the rate of clinical and radiological fusion, the stabilisation of the joint or prevention of further neuropathic bone disintegration in group A, and the operative morbidity. Additionally, we studied the reduction in the incidence of ulcers after operation. We excluded 31 patients with a follow-up of less than two years from this analysis. Finally, we identified if the patients were able to wear standard footwear after treatment. 

Results
The types of procedure performed are summarised in Table I and the type of fixation used in Table II. The median time in the cast was six months (2 to 12) with a median time of three months (0 to 10) for non-weight bearing and three months (0 to 8) for weight-bearing.
Primary outcome. In group A, in 24 feet with recurrent neuropathic bone disease, 17 obtained stability with no further swelling and in seven, symptoms recurred post-operatively. The rate of fusion in group A was 87% (21 of 24 feet). Of the 20 feet in this group with deformity, correction was achieved in 13. In group B, containing 86 feet with adequate follow-up in which deformity was the indication for surgery, correction was successful in 67 and unsuccessful in 19.

Overall, fusion was obtained in 97 of 110 feet (88%) with failure to achieve fusion in 13. Of these 13 feet, nine required revision and two of these ultimately required amputation. Adequate stability with fibrous union was achieved in four, and one of the nine revisions also obtained adequate stability from a fibrous union. In the whole series, failure to achieve correction of deformity occurred in 26 of the 106 deformed feet (25%), of which 12 (46%) required subsequent surgical revision.

Other complications included infection in 28 feet (25%) and breakage of a staple in one. Ulceration while in plaster occurred in ten feet (9%). In total, 58 of the 110 operations (53%) had complications. These resulted in amputation in four feet in the immediate post-operative period and re-operation in 12, including those mentioned above.

Further progression of disease led to amputation in another five. In total there were nine amputations.

Secondary outcomes. In the 79 patients who had deformity and a minimum follow-up of two years, the mean pre-operative frequency of ulceration was 0.18 ulcers per month. Post-operatively this was reduced to 0.06 ulcers per month. The frequency of ulceration decreased in 40 feet (50%), remained approximately the same in 28 (35%), and became worse in eight (10%). Three feet lacked adequate operative records for comparison.

Normal footwear could be worn by 32 patients (40%) after surgery while half required a moulded insole. Amputation became necessary in seven feet (8%) in this subgroup, and in two instances the type of footwear was not documented. The overall rate of failure in our study was 12%.

Discussion

Achieving a satisfactory arthrodesis in a neuropathic foot is a challenging task. Failure to achieve fusion has been reported to range from 0% to 67%.12,13 Papa et al12 reported a rate of non-fusion of 34% in patients with diabetic neuropathic bone disease with a protocol which kept the patients non-weight bearing for two months. Shibata et al9 found a rate of non-fusion of 27% in ankles with neuropathic bone disease secondary to leprosy. They kept the foot non-weight bearing for three months after operation, whereas Ebenezer et al11 allowed weight-bearing at one month, which is similar to our protocol. They had a rate of fusion of 100%. Saltzman et al14 had a rate of non-fusion of 19% in a group of patients of mixed aetiology, but with normal sensation in most cases.

Many factors can affect the rate of fusion including age, the type of deformity, the type of procedure, the method of fixation, the presence of infection, the blood supply and the time in the cast. Although our study is the largest of its kind to be published to date, the large number of variables relative to the number of patients precludes meaningful multivariate analysis aimed at determining the cause of failure of fusion. In our series, five patients obtained a fibrous pseudarthrosis with sufficient stability to tolerate walking, similar to the experience of Papa et al.12

Neuroarthropathy has been described in four stages9,15 with stage 0 defined as warmth and instability with minimal or no radiological change, stage 1 as development, stage 2 as coalescence and stage 3 as reconstruction.16 Arthrodesis was believed to be most difficult to achieve at stage 3. All our patients were in stage 2 or 3 at the time of surgery. It has been suggested that surgery should be deferred until the period of reconstruction/consolidation since earlier operation may leave the surgeon dealing with highly unstable bone that can be cut with a scalpel and will not hold fixation.3

While the basic principles of Drennan et al10 were followed, there are some differences between neuropathic knees and neuropathic ankles. At the ankle minimal cartilage and synovial tissue is found, and not infrequently the joint may be found to be partly fused. Therefore, minimal debridement of these tissues is usually required and fixation is more appropriately obtained by staples and/or pins, rather than an intramedullary nail.

In other studies joint deformity was the most common indication for surgery.9,11,12,14,17 We achieved correction of deformity in 80 of the 106 operations (76%), similar to that of 83% by Shibata et al,9 with success defined as a residual deformity of less than 10%. Ebenezer et al11 found successful correction with no residual deformity in 62%, but Saltzman et al14 obtained successful correction in only 22% of their cases. Failure of correction in all these studies is most likely to be related to the severe degree of deformity at presentation. The methods of fixation may also be implicated. In our institution, because of the high cost of cannulated screws and the lack of intra-operative fluoroscopy, only staples and Kirschner wires were used in most cases. Papa et al,12 using cannulated screws, reported successful correction of deformity in 93% of cases. Additionally, several of our patients had a rocker-bottom foot with collapse of the midfoot, which is difficult to correct.

The overall rate of complications was high, with 58 of 110 feet (53%) developing problems after operation. The infection rate was 25% and exceeded that of other series.6,9,11-13 The skin condition in our patients was poor with deep cracks in which microflora could reside. Long-term follow-up showed that 8% of feet ultimately required amputation but this figure was in keeping with that of other series.6,9,11-13

The most common indication for arthrodesis in our study was recurrent ulceration secondary to deformity.
Arthrodesis, by making the foot plantargrade again, improved the distribution of weight, encouraging ulcers to heal and reducing the risk of future ulceration. In our study ulceration after surgery was reduced in 50% of feet. Two factors could have significantly affected our results. First, presentation was usually late and secondly, these patients generally delayed their return to hospital until they had recurrent ulceration. Shibata et al found recurrent ulceration in seven of 24 patients with a mean follow-up of nine years. Ebenezer et al described a rate of ulceration of 0.43 ulcers per year after arthrodesis. However, arthrodesis will not completely prevent recurrent plantar ulceration. This may be due to the failure to achieve complete correction of deformity in all cases, which would leave the ulcer-prone skin still exposed to high pressure-loading on weight-bearing. In addition, previous ulceration may have destroyed the resilience of the plantar surface to withstand even normal amounts of stress. In most of these patients, the subcutaneous fat is likely to have been replaced by stiff fibrotic scar tissue which is poorly vascularised and has a low tolerance to shear stress. Fasciocutaneous flaps such as the medial plantar artery flap, have been used to replace the ulcer-prone skin with more healthy skin and subcutaneous fat, and have been shown to reduce the rate of recurrent ulceration. Neuropathic feet are prone to ulceration because of lack of protective sensation. The lack of autonomic innervation greatly reduces sweat and production of sebum, making the entire surface of the foot prone to cracking due to dessication of the skin. Therefore, education of the patient in foot care and wound prevention remains an integral part of the rehabilitative process.

Overall, 40% of our patients were able to wear normal shoes after corrective surgery and a further 50% received moulded footwear. While some authors routinely practice the wearing of ankle-foot orthoses and or orthotic shoes after corrective surgery and a further 50% received moulded footwear. While some authors routinely practice the wearing of ankle-foot orthoses and or orthotic shoes after corrective surgery, others do not.

In our study 75% of our patients wore normal shoes with a semi-rigid sole in the first year and a microcellular rubber instep of the sole.

Selected references: